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# Cow hair allergen concentrations in dairy farms with automatic and conventional milking systems: From stable to bedroom

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ABSTRACT

Bovine hair and dander are considered to be a notable risk factor for sensitization and allergic symptoms in occupationally exposed cattle farmers due to various IgE binding proteins. Farmers are suspected not only to be exposed during their work inside the stables but also inside their homes as allergens could be transferred via hair and clothes resulting in continued bovine allergen exposure in private areas. In recent years a new sensitive sandwich ELISA (enzyme linked immunosorbent assay) test has been developed to measure the cow hair allergen (CHA) concentration in dust. The aim of the present study was to determine the CHA concentration in airborne and settled dust samples in stables and private rooms of dairy cattle farms with automatic milking systems (AM) and conventional milking systems (CM), also with respect to questionnaire data on farming characteristics. For this purpose different sampling techniques were applied, and results and practicability of the techniques were compared.

Dust sampling was performed in the stable, computer room (only AM), changing room, living room and bedroom (mattress) of 12 dairy farms with automatic milking systems (AM group) and eight dairy farms with conventional milking systems (CM group). Altogether, 90 samples were taken by ALK filter dust collectors from all locations, while 32 samples were collected by an ion charging device (ICD) and 24 samples by an electronic dust fall collector (EDC) in computer rooms (AM) and/or changing and living rooms (not stables). The dust samples were extracted and analyzed for CHA content with a sandwich ELISA.

At all investigated locations, CHA concentrations were above the limit of detection (LOD) of 0.1 ng/ml dust extract. The median CHA concentrations in dust collected by ALK filters ranged from 63 to 7154 μg/g dust in AM farms and from 121 to 5627 μg/g dust in CM farms with a steep concentration gradient from stables to bedrooms. ICD sampling revealed median CHA contents of 112 μg/g airborne dust in the computer rooms of the AM farms and median CHA loads of 5.6 μg/g (AM farms) and 19.8 μg/g (CM farms) in the living rooms. Passive dust sampling by EDC was performed only at two locations in the AM group resulting in median CHA values of 116 μg/$m^2$ (computer room) and 55.0 μg/$m^2$ (changing room). Except for the stable samples the median CHA load was lower in AM farms compared to CM farms. The CHA contents of ALK filter samples were significantly correlated in most locations. Differences between the farming types were not significant. Although allergen transfer to the private area of the farmers has been found and results from several locations were correlated, differences in CHA concentrations were not significant with respect to questionnaire data such as the wearing of stable clothes in living room, free access of pets to stable and home, frequency of hair washing. All sampling techniques seem to being practicable for simple and effective CHA measurement.



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## 1. Introduction

Dairy farming is a main branch of the agricultural sector in Germany and many other countries. Cattle farmers are occupationally exposed to a variety of bioaerosols of which some components are considerable risk factors for airway diseases. Among them, the lipocalin Bos d 2 is known to be a major respiratory allergen, but several other bovine IgE binding proteins have also been identified in cow hair and dander (Ylonen et al., 1992; Rautiainen et al., 1996; Heutelbeck et al., 2009; Zahradnik et al., 2011a). Clinical symptoms of the exposed workers can reach from asymptomatic sensitization, rhinitis up to severe asthmatic attacks with lung function impairment (Reynolds et al., 2013) leading to a high rate of initial employment disabilities in Germany, as reported by the German Social Insurances for Agriculture, Forestry and Horticulture (LBGs), and other European countries (Kogevinas et al., 1999; Radon et al., 2001; Heutelbeck et al., 2007; Elholm et al., 2010). This is of high public health relevance with respect to the large number of young adults being confronted with grave economic and personal consequences. To reduce the allergen exposure, many farmers introduced personal protective equipment (e.g.; masks, overalls, hair caps) during their work inside the stables and modified their stables (e.g.; installation of automatic milking, changing rooms). Automation of working processes can help to facilitate working steps, and robotic systems like automatic milking systems (also known as robotic milking) or feeding dispersers have already been installed by many dairy farmers. Nevertheless, despite prevention strategies, notable amounts of dust and bovine allergens could be quantified in the working and also in the living environments of cattle farmers suggesting an allergen transfer into the private rooms. This has been shown for the major allergen Bos d 2: Berger et al. (2005) and Hinze et al. (1997) described a strong relationship between the concentration of bovine allergens in dust from farmers' homes and the sensitization of farmers. Notable concentrations of Bos d 2 in settled dust from sheds but also from the farmers' dwellings (living rooms, mattresses) were measured by a Rocket immunoelectrophoresis using an anti-Bos d 2 antibody. Meanwhile, this Bos d 2-test has been no longer commercially available and a new and more sensitive sandwich ELISA (enzyme linked immunosorbent assay) test has been developed to measure the exposure to cow hair allergens (CHA) in airborne and settled dust (Zahradnik et al., 2011b).

The aim of the study was to determine the CHA concentration in airborne and settled dust samples from dairy cattle farms with automatic milking systems compared to conventionally equipped farms and to investigate the allergen transfer from the working areas to the living areas of farmers, also with respect to questionnaire data on farming characteristics. Three different sampling methods were performed, and the results and the practicability of sampling strategies were compared.

## 2. Materials and methods

### 2.1. Participants and study sites

Altogether, the farmers of 20 dairy cattle stables were contacted, of which 12 farms were equipped with automatic milking systems ("milking robot") and 8 farms applied "conventional" milking systems (other than milking robots). The 12 farms with automatic milking systems (AM farms) were located in the north-eastern region of Bavaria (South Germany) and telephonically contacted by a fieldworker in cooperation with the regional Social Insurance for Agriculture, Forestry and Horticulture. The 8 dairy cattle farms with "conventional" milking systems (CM farms) from neighbouring Bavarian regions were directly contacted by the field worker per telephone. Subsequently, all farms were personally visited by the field worker for providing more detailed information.

A room between the stable and the living area, where farmers could change their clothes and shoes and had the possibility to wash their hands or take a shower ("changing room"), was necessary for inclusion in the study and existent in all contacted farms. Presence or absence of allergic symptoms of the farmers was no recruitment criterion and was not evaluated, but farmers with a current official announcement of an occupational disease were not contacted. All contacted farmers agreed to participate in the study and informed consent was obtained from all study participants.

"Conventional" milking systems comprised/defined other systems than milking robots (e.g.; herringbone parlour, swing-over, side-by-side parlour, milking pipeline) with close animal contact, but detailed information on type and placement of these systems were not collected. The milking robots of the AM farms, however, were either installed in a corner inside or in a compartment directly adjacent to the stable and were operated from a computer room adjoining the cow stable.

Farming types and study site characteristics were representative for the region of Bavaria, but not necessarily for Germany in general. Data on study sites' characteristics and working/living conditions of the AM farms and CM farms (e.g.; number of cows, type of cattle breed, housing system and bedding) were collected via questionnaire and by observation of the field worker during the first visit, and the evaluation of these data is summarized in Table 1. Moreover, data regarding the farmers' practices, which are likely to contribute to allergen transfer from working to private areas (e.g.; frequency of hair washing, wearing of stable clothes inside private rooms, free access of cats/dogs to stable and living area) were collected via yes/no questions..

### 2.2. Sampling strategy

Between November 2009 and March 2010 dust sampling was performed at five locations inside the cow stable area (next to milking robot/milking parlour and adjacent computer room) and inside the farmers' dwellings (changing room, living room and mattress in the farmers' bedroom). Three different sampling techniques for dust collection were used according to a standardized protocol: (1) ALK filter dust sampler, (2) Ion-charging device Ionic Breeze Quadra (ICD) and (3) electrostatic dust fall collector (EDC).

While settled dust sampled by the ALK device was collected from all sampling locations of all participating farms, ICD and EDC sampling of airborne dust could not be performed at all locations due to practicability and capacity reasons: As only two ICD devices were available to run in parallel, only the computer and living room were monitored. EDC sampling was restricted to the computer and the changing rooms, as the amounts of settling dust were expected to be very high in the stables and very low in the sleeping rooms for adequate results. All samples were collected by the same field worker in order to provide comparable sampling conditions. Number of dust samples, sampling technique and sampling locations are shown in Table 2.

### 2.3. Sampling techniques

#### 2.3.1. ALK filter sampling device

Collection of reservoir dust from floors and other easily accessible surfaces in computer, changing and living rooms (e.g.; desktops, window sills, floors) and from mattresses was performed using a ALK sampling device consisting of a conventional vacuum cleaner (Miele S S624) fitted with ALK filters (ALK Copenhagen, Denmark), as described in detail by Waser et al. (2004) and Berger et al. (2005). The ALK filters were stored at room temperature and transferred within five days to the laboratory of the Institute and Outpatient